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Short Synopsis

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Eco-friendly management of Early Blight of Tomato caused by *Alternaria solani* in Faridabad District.

DEPARTMENT OF BIOTECHNOLOGY

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ABSTRACT

Early blight of tomato caused by *Alternaria solani* is the most devastating disease worldwide. It is responsible for 80 % economic losses sustained by tomato producers each year in world. It is one of the most threatening diseases which can hamper the plant development in all stages. The disease can result in severe reduction in quality and quantity of fruit yield. Hence, it is of prime importance to focus on the ecofriendly and cost effective management of *Alternaria* blight of tomato. Estimation of disease severity in villages will be carried out to understand the present scenario of tomato field in and around Faridabad. Evaluation will help to find out the resistance responses of tomato plants to different isolates of the pathogen. *In vitro* and *in vivo* analysis will suggest more about suitable biological management approach. Development of IDM strategies comprising botanicals and bio-agents will reduce the use of chemical treatments which are hazardous to human health thus, providing an environmentally and economically appropriate means of management for early blight disease of tomato.

Key words: *Alterneria solani*, botanicals, early blight, ecofriendly, tomato

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1. INTRODUCTION

Tomato *(Lycopersicon esculentum* Mill.) of Solanaceae family is an important vegetable worldwide. Among the vegetables tomato ranks first among the processing crops. It is very good source of vitamins A, B, C and minerals. They are rich in suitable contents of minerals viz. iron, calcium, potassium, phosphorus and sulfur. The tomato belongs to nightshade family. The plant typically grows to 1-3 meters in height and has a weak stem. It is a perennial in habitat and grows in temperate climate as an annual. It is world's most important agricultural product also known as 'super food'.

Tomato cultivation had become popular since mid 19th century because of its varied climatic adaptability and high nutritive value. Tomato crop is highly susceptible to plant pathogens viz. bacteria, fungi and viruses which deteriorate the yield and quality of tomato fruit (**Pattnaik *et al*. 2012).** Early blight disease is one of the world's most catastrophe diseases resulting in economic yield losses. The disease appears on leaves, stems, petiole, twig and fruits. Symptoms appear as small black or brown spots on lower leaves after fruit set. They are usually about 0.25 to 0.5 inch in diameter. Spots are leathery and develop darker borders with a white centre. The spots are in concentric pattern. As the disease progresses the color of the leaves turn yellow brown and drop off. In the centre of spots black pycnidia develops which when become wet ooze out the fungal spores. The spores of the fungus are spread by insects, human contact, water and air. Favorable conditions for the disease are overhead irrigation, wet and warm weather conditions. A period of about 48 hour is required for infections to occur but it may be cumulative over several days not necessarily the continuous period. In garden the plant debris serve as inoculums source for primary infections in the spring.

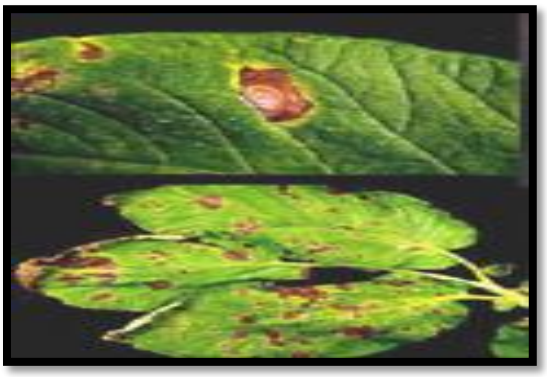


Figure 1:Lesions formed by *Alterneria solani*

Figure 2: Spots develop due to early blight disease

The spores of the fungi are the means of dissemination and also helpful in the identification and the classification of an organism. It was well established that the tomato early blight fungus could survive on the infected seeds for several days. But it is still speculative whether the seed borne inoculums of *A. solani* serves as a source for triggering primary infection in the next season (**Neergard 1995**).The ability of pathogen to survive for a long time in the diseased plant parts and soil on the alternative collateral hosts in the absence of main host determines the ability of pathogen to perpetuate **(Basu, 1971; Moore and Thomas, 1942 and Rands, 1917**).

Figure 3: Multiple conidia of *A. solani*

Figure 4: Single conidia of *A. solani*

Alternaria spores develop in single form or in chains. They are highly septate, club shaped divided in both horizontal and vertical directions. The surfaces of the spores are smooth but may contain some rounded warts which create roughness. *Alternaria solani* consists of polycyclic life cycle. It reproduces asexually. It is a deuteromycete which reproduces by means of conidia. The life cycle starts with the fungus overwintering in crop residues, during the spring conidia are formed. Multicellular spores enter in the uninfected plant through small wounds or stomata when splashed by water or wind. Infections of the disease usually start on older leaves. The fungus form lesions of brown black color. More of conidia are created in these lesions and are released, which further infect other plants. Moisture and high humidity plays essential role for the growth of infection. Period of time from occurrence to emergence of symptoms is based on leaf age, susceptibility of cultivars and environmental factors. Prevalence and severity of disease become highest when plants grow mature. Sporulation can occur under the alternating dry and wet time periods. The repetition of disease cycle increases the potential to spread infection rapidly and build up to damage crops on high level (**Chaerani *et al.* 2006).**

Toxins are released by plant pathogens which cause severe damage to the tissues of plant parts (**Suvarnalatha devi *et al.* 2010**). The indiscriminate application of agrochemicals had resulted in toxicological problems in food chain. The necessity to investigate into the effect of different botanical extracts will minimize the incidence of pathogen and increase crop yield. Several workers have reported that biological agents and plant extracts are ecofriendly sources to reduce the use of fungicides (**Chethana *et al.* 2012**). The development of resistant strains of pathogen obstructs in the management of the disease. It has given a thrust to develop efficient methods of biological control to reduce the disease with minimum usage of fungicides.

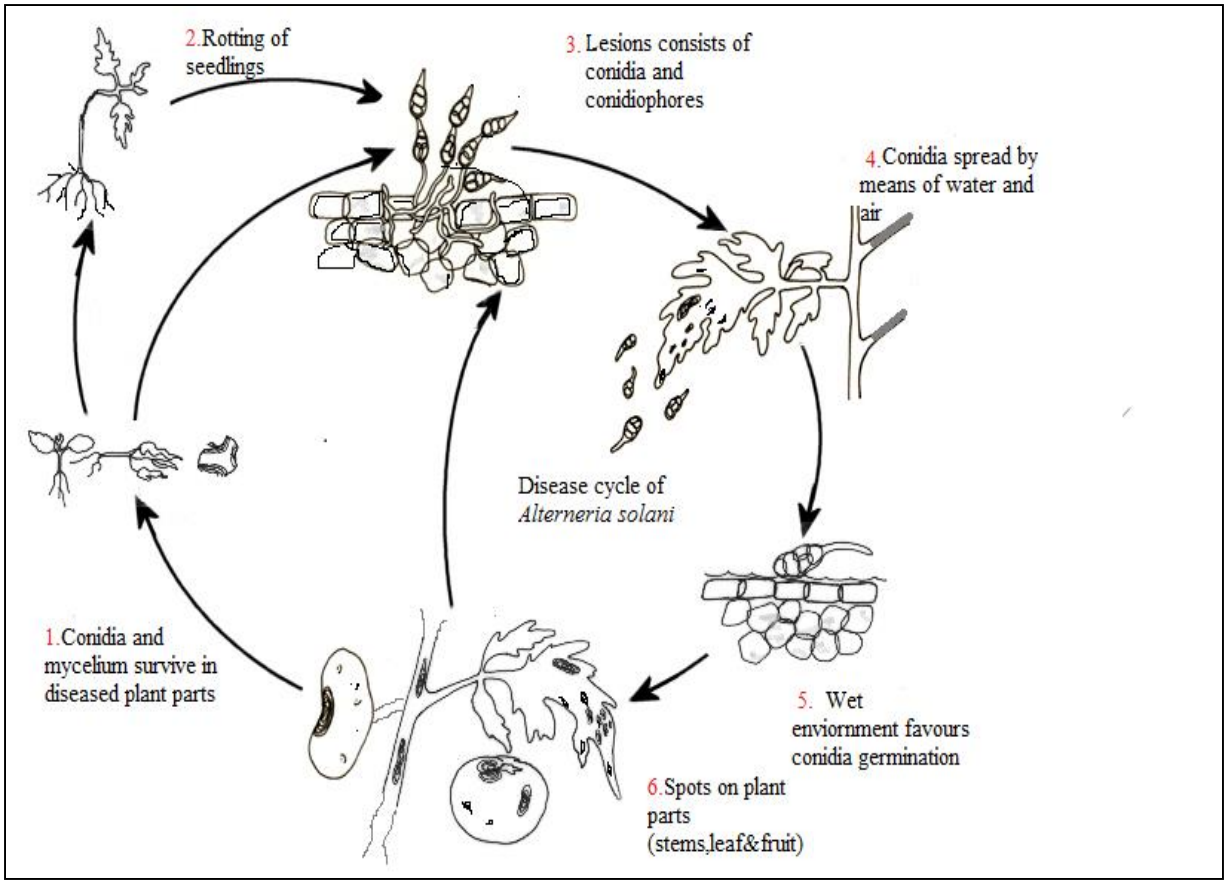

2.Rotting of seedlings
3. Lesions consists of conidia and conidiophores
4.Conidia spread by means of water and air
Disease cycle of Alterneria solani
1.Conidia and mycelium survive in diseased plant parts
5. Wet enviornment favours conidia germination
6.Spots on plant parts (stems,leaf&fruit)

Figure 5: Disease cycle of *Alterneria solani*

2. LITERATURE REVIEW

Alternaria solani causes early blight which is an important widely distributed disease throughout the world and it occurs in mild to severe form in different parts of India. It is present in various diverse forms. Reports are available in literature on different aspects of this disease.

Tomatoes *(Lycopersicon esculentum* Mill.) are prime contributors to the diet of human nutrition. They are cultivated as economically important crop worldwide. Early blight of tomato caused by *Alterneria solani* is most significant disease of tomatoes reducing the yield from 35 to 78% **((Basu, 1971; Datar & Mayee, 1981)**. The survey for prevalence of early blight of tomato caused by *A. solani* was conducted in local cultivars and recorded maximum disease incidence by various researchers. A survey was conducted by **Prasad (2002)** during Kharif season in Northern districts of Karnataka viz. Raichur, Dharwad, Gulbarga and recorded a percent disease index of 65.36. **Abhinandan *et al.* (2004)** conducted a survey in Punjab, India and found maximum disease intensity at the Tapa District and minimum disease intensity of 8.2 percent was observed at the Babakala District. It was observed that disease incidence was increased due to favorable weather conditions such as suitable temperature (24-29ºc) and high humidity. The disease appears on plant parts viz. stems, leaves, fruits etc. causing drying, premature falling and leading

to death of plant. The characteristic symptom for early blight of disease is dark leaf spots with concentric patterns surrounded by chlorotic disc caused by secretion of toxins. **Fritz *et al.* (2006)** stated that the toxin isolated from lesions when introduced to tomato plants caused necrosis and chlorosis of leaves thus damaging host plant to the fuller extent. The investigations carried out indicated the disease to be disastrous causing heavy losses in terms of agriculture economics. During the survey in Hyderabad district **Jiskani *et al.* (2007)** estimated the disease incidence with highest frequency (60.0%) of *Macrophomina phaseolina, Alternaria solani and Verticillum albo-atrum.* **Kumar *et al.* (2008)** conducted the pathogencity test of *A. solani* and found the species to be virulent. Different isolates of *Alterneria* were isolated by **Elwakil *et al.* (2009)** from onion varieties and proved their pathogenecity or virulence by Koch's postulate method.

Now, it is well established that species of *A. solani* are found to be virulent therefore it becomes essential to understand the plant pathogen interactions. Morphological and physiological studies are important aspects in identification and characterization of the pathogen. During morphological investigations, **Abubakar and Ado (2009)** stated minor variations in shape dimensions in conidia of *Alternaria* species due to climatic factors and hence were considered to lie within the boundaries of species. Plants develop systemic resistance against the toxins released by the pathogen. **Suvarnalatha devi *et al*. (2010)** isolated various toxins from the pathogen. **Shahbazi *et al.* (2010)** investigated the higher content of phenol and peroxidase activity in plants infected by the disease to protect itself from invasion of *A. solani*.

The development of fungicidal resistant strains of pathogen had created difficult issue for the farmers to save the tomato crop from the assault of *A. solani.* Increased use of agrochemicals had resulted in harmful hazards against humans and environment. Different methods were employed by agricultural scientists to increase the yield and reduce the disease caused by *Alternaria* by the evaluation of fungicides, botanicals and bioagents. **Pattnaik *et al.* (2012)** suggested that the applications of various plant extracts are growth promotive and cost effective. An investigation was carried out by Ganie ***et al.*** **(2013)** of the integrated management programme of the disease to find safe, ecofriendly and efficacious natural products against the pathogen. However, literature survey revealed that research is still required to obtain the practical effectiveness of botanicals to minimize the residual hazards of fungicides.

3. DESCRIPTION OF BROAD AREA

Early blight of tomato is the most destructive disease that causes severe loss of tomato at seedling and fruiting stages resulting in great economic losses. It can cause a decrease in the quality and quantity of the yield. The disease severity leads to complete defoliation and death of the plant. The percent disease incidence needs to be estimated through the survey in the fields of tomato in villages of Faridabad in particular. The morphological and physiological studies of *Alterneria* will enable to understand the relationship between variability of weather and disease development factors for an effective management of disease.

The intensity and indiscriminate use of fungicides and chemicals in agriculture has caused many hazards to the environment. This study is being undertaken to minimize the negative effects of chemicals and development of the alternative control of plant disease, which includes the use of botanical extracts and biological controls. This will induce the resistance through direct antimicrobial activities which is a ecofriendly approach. *In vitro* and *in vivo* studies will suggest more about suitable biological management techniques.

Development of IDM strategies will prove to be growth promotive, cost effective and non hazardous in agro-ecosystem. The combination of appropriate biocontrol methods and bioagents with minimum use of fungicides will provide an environmentally and economically appropriate means of the management of early blight disease of tomato.

4. OBJECTIVES OF RESEARCH

1. To survey and estimate disease severity in the fields of tomato in and around Faridabad in Haryana.

2. To isolate, identify and prove pathogencity of the pathogen causing early blight of tomato.

3. To undertake the morphological, cultural, physiological and nutritional status of *Alternaria solani*.

4. To evaluate different plant extracts, bioagents and fungicides against *Alterneria solani* in vitro conditions.

5. To screen selected botanicals, bioagents and fungicides for ecofriendly management of disease *in vivo* conditions

6. To develop IDM strategy to be implemented by the farmers.

5. METHODOLOGY TO BE ADOPTED

The investigation of early blight disease of tomato will be conducted in the fields of Faridabad.

5.1 Survey and surveillance for estimation of disease severity in the fields of tomato in and around Faridabad in Haryana

An intensive survey will be conducted in the villages of Faridabad to know the percent disease index of early blight disease in tomato field. In about twenty villages each field will be surveyed. In each field, few plants will be selected randomly and disease severity will be assessed by using percent disease incidence **(Vincent, 1947**).The name of villages where survey will be done are Gharora, Sotai, Jajru, Bahian , Chandawali, Dayalpur, Machhgarh, Nariyala, Atali, Mauzpur,

Chhanysa, Mohna, Shahpura, Sunpeed, Sahpur Fatehpur, Sadpura, Kakdipur, Aterna, Katesra, Dadota, Jawa in Ballabgarh and Palwal district. The infected area will be determined by eye estimation for percent of disease index (PDI), i.e. severity for early blight of tomato. Data will be analyzed statistically.

5.2 Isolation Identification and proving the pathogencity of the pathogen causing early blight in tomato

Alternaria solani isolated from tomato plants will be collected during the survey from different villages of Faridabad based on the nomenclature used by **Shahbazi *et al*. (2010)**. The isolates of *A. solani* will be stored at 5°c in refrigerator and sub cultured periodically at interval of 30 days.

Pathogencity tests of pathogen isolates will be done in green house conditions. Recording of severity of disease will be carried out after the period of two weeks of inoculation. The intensity of disease will be recorded according to chart scale suggested by **Latha *et al.* (2009).**

5.3 Morphological, Cultural, Nutritional Physiological (pH, Temperature and Light) studies of the Fungus causing early blight

The morphological, cultural, nutritional and physiological variability of *A. solani* will be carried by as described by **Naik *et al*. (2010)**, **Ramjegathesh *et al*. (2012).**

5.4 *In vitro* evaluation of fungicides, botanicals and bioagents against *Alterneria solani*

The poison food technique will be used *in vitro* for fungicides, botanicals and bioagents. Data on the disease severity will be recorded according to the disease rating scale as described by **Gondal *et al.* (2012).**

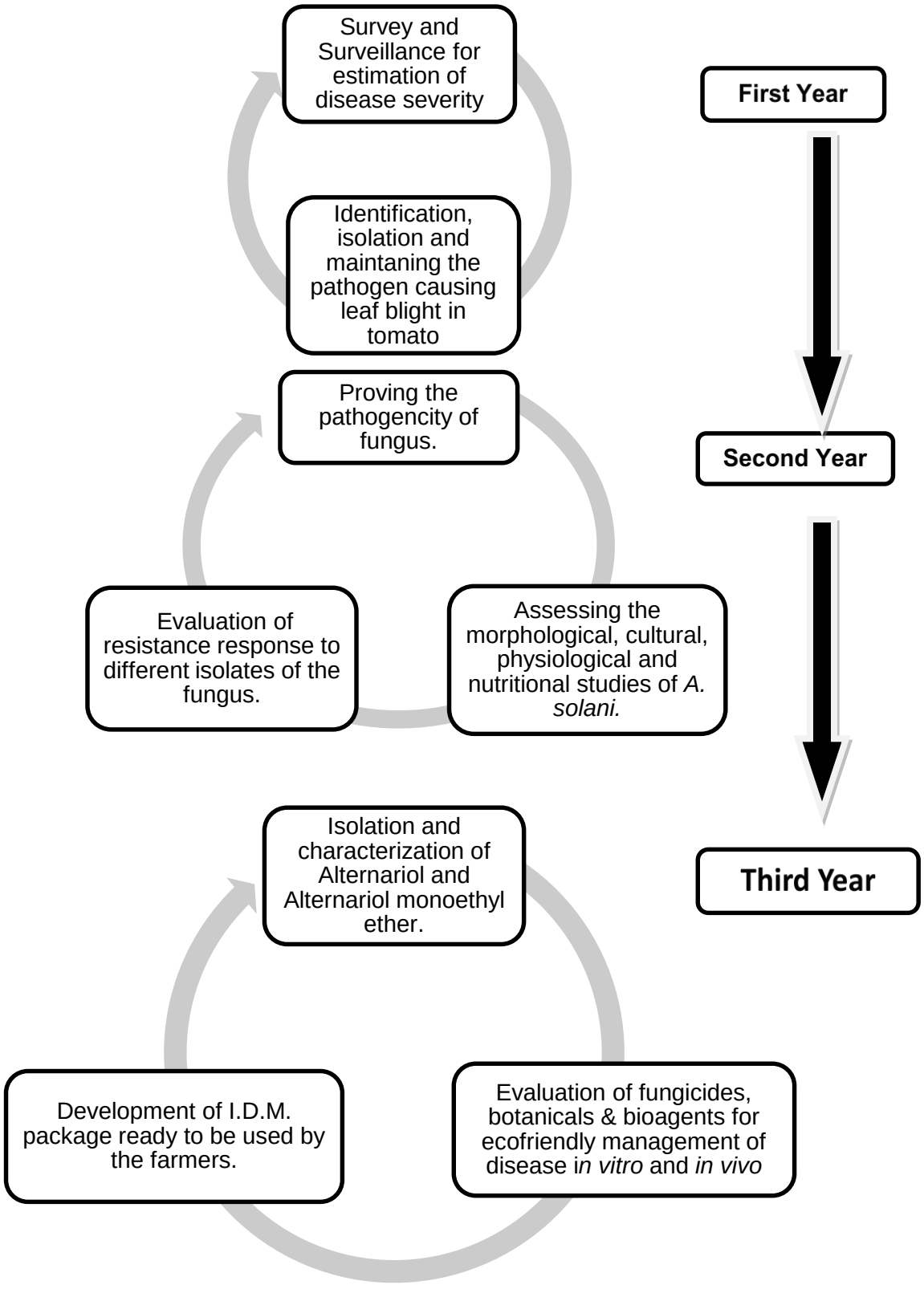
5.5 *In vivo* screening of selected botanicals, bioagents and fungicides for ecofriendly management of disease.

Efficacy of botanicals and bioagents against *A. solani* under green house conditions will be investigated by adopting the procedures described by **Derbalah *et al.* (2011)** and **Nashwa *et al.* (2012).**

5.6 Develop IDM strategy to be implemented by the farmers

Integrated disease management strategy will be planned by keeping in mind the suitable plant extracts, bioagents and fungicides which will be further used in field experiments for increasing the yield of tomato as described by **Ganie *et al*. (2013)**

6. RESEARCH PLAN


First Year
Survey and Surveillance for estimation of disease severity
Identification, isolation and maintaning the pathogen causing leaf blight in tomato
Proving the pathogencity of fungus.
Second Year
Assessing the morphological, cultural, physiological and nutritional studies of A. solani.
Evaluation of resistance response to different isolates of the fungus.
Third Year
Isolation and characterization of Alternariol and Alternariol monoethyl ether.
Evaluation of fungicides, botanicals & bioagents for ecofriendly management of disease in vitro and in vivo
Development of I.D.M. package ready to be used by the farmers.

7. PROPOSED/EXPECTED OUTCOME OF THE RESEARCH

Management of early blight of disease caused by *Alterneria solani* is needed to maintain the quality and quantity of tomato plant. Different agronomic and horticultural approaches led to rely on chemical fungicides. To save the environment from the misuse of agrochemical crop management researchers have focused on development of biological methods to control the disease. A variety of plant extracts and biocontrol strategies are available for implement. This research will help in better understanding of complicated interactions among humans, plant and environment. It will present an integrated survey for the practice of strategies to the suppression of plant pathogen disease. Biologically active plants have pesticide potentials which play significant role in the strategies of crop protection and management. Secondary metabolites or antimicrobial chemicals from the plants are more naturalistic and environment friendly. Appropriate integration of numerous ecologically sound treatments like botanicals and bioagents with minimum use of fungicides may provide a superior management of disease.

The expected outcome of this research work is the use of environment friendly and cost effective applications to manage early blight disease of tomato. For better understanding of plant pathogen interactions, the different isolates of *Alternaria solani* will be collected from the different fields of villages of Faridabad. Understanding the difference in strains of *A. solani* due to different environmental conditions of field will help to generate better biological fungicides with minimum environment hazards. The development of I.D.M. package and distributing it to farmers will prove beneficial for them. It will not only help in saving their land from harmful chemicals but also help them to increase the yield of their crop. Farmers can make and sell their own IDM package to improve their livelihoods.

8. SIGNIFICANCE

Early blight of tomato is the great cause responsible for the reduction of tomato production in the country. Maximum investigation is still in requirement for knowing the interactions between tomato plant and blight pathogen, *Alternaria solani* due to the emergence of new virulent races of fungicides resistant strains. Increased usage of fungicide had led to the increase in overall expenditure of crop production thus causing enhancement of the selling price of tomato. Due to the lack of safety measures adopted by farmers chemical pesticides had caused negative impacts on environment. The proposed research plan includes the identification a isolation of the pathogen to understand the plant pathogen interactions for the better estimation of ecofriendly management practices. The research focuses on the lesser use of fungicides as they are not only expensive, inefficient on the other hand accumulates in food chain and can cause genotoxic activity in humans. It focuses on efficacy of botanical extracts against the pathogen by keeping in mind safety issues on human health.

The botanicals and bio-agents are indigenously accessible, cost effective, easily available and have high potentials to reduce plant pathogen and increase yield of crops. Usage of

biopesticides is of great importance as they are biodegradable in nature and also protects non targeted organisms. Polycyclic and soil borne diseases can be controlled effectively by biological control agents that act as control as bioprotectants and self perpetuating. IDM package has the capability to change the physiochemical characteristics of the soil and improve the health of a plant.

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